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ABSTRACT

Considering what is known about computers, reading strategies, and cognitive theory, there is no doubt that computer technology has the potential to make a difference in schools. However, program development and school site implementation need careful guidance from educators and researchers who are knowledgeable about process research, aware of school needs, and sensitive to school conditions. Instructional use of computer technology is presently limited in scope, haphazardly organized and administered, and accompanied by software that does not reflect current knowledge of the reading process. Many teachers and administrators are uncomfortable with computer technology and are uncertain about its ability to benefit school programs. If the issues of implementation and acceptance are not addressed jointly by educators and the computer industry, innovative learning experiences and computer literacy may be accessible only to select groups--increasing, rather than helping to eliminate, equity problems in both school and society. (HOD)

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COMPUTER TECHNOLOGY AND READING INSTRUCTION: PERSPECTIVES AND DIRECTIONS

Judith A. Langer
University of California, Berkeley

The computer revolution is well under way. One need not look far to see the great impact it has had on the business world and on our daily lives. Computer games, text editors, and microcomputers are widely advertised and can be seen in a variety of computer shops springing up on main streets and shopping malls across the country. Businesses are replacing electric typewriters and conventional file systems with microprocessors and text editors. Even relatively small companies and stores are using microcomputers for payrolls, inventory management, data storage, and information retrieval. In local communities, people of all ages have become habitues of computer arcades that have gained astonishing popularity. Amusement centers, family restaurants, diners, bars, and even local sweet shops have taken on a new look; from one to a dozen computer games now line their walls and are frequented by people from 8 to 80 playing Space Invaders, Pacman, and other popular computer games. Some parents and school district personnel are even blaming unexcused school absences on students' preoccupation with computer games and, in some localities, seeking legislation to limit computer arcade availability to after-school hours.

In addition to having captured the public's imagination with innovative and highly absorbing games, the microcomputer industry has developed an extensive home computer package with options for family budgeting, personal investment, business management, and more effective record keeping.

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Many home computer games include instructional components and parents are encouraged to buy them as educational toys. More directly, instructional and quasi-instructional programs are rapidly being developed for home use. Private homes and public arcades are filled with children as young as 10 or 12 teaching adults how to use computers and play the games. Despite protestations to the contrary, microcomputers are almost everywhere and children are being affected.

Some schools have become involved in computer instruction and the revolution will no doubt have an increasingly profound effect on home and school learning -- with or without the involvement of educators. The curious and seriously distressing problem is that the computer industry has focussed its educational materials on the home market, and homes have sometimes had to drive schools to become involved. Inadequate instructional software exists for school use and new programs are being developed by a rapidly growing number of software-for-education companies. However, educators and educational researchers do not tend to be consulted by either hardware or software manufacturers to help set the goals, functions, or implementation of the new instructional programs. A major mode of communication and learning has been developed in this century, and the instructional aspects are being permitted to <u>happen to</u> rather than be <u>shaped by</u> professional educators who know about children, schools, and learning.

<u>Schools and Technology -- Background</u>

Although we are living in a technological age, schools have remained disproportionally untouched by the products of the burgeoning industry. A walk through many school storage rooms of today discloses dusty stacks

of such technological equipment as overhead projectors, individual filmstrip viewers, opaque projectors, microfiche readers, and single concept film loop viewers that were purchased in large scale during the late 1960s and early 1970s when federal funds for educational innovation were relatively easy to come by and alternative methods for individualizing instruction were being sought. At that time, audio-visual courses were offered as regular in-service, audio-visual specialists were often appointed to consult with teachers, and aides were hired to assist in the changing modes of instruction. All this, yet technology in education failed to take substantial hold. Then, as now, both hardware and software were used relatively little except by the smitten few -- those teachers who became excited by the motivational and educational potential of the new technology. As for computer assisted instruction (CAI) in particular, the schools of the sixties often found that after a few years teachers and students became disenchanted and began to seek other more conventional materials. These early CAI programs were often designed as independent curriculum packages that focussed on drill and practice of identifiable and testable subskills that recycled or changed with the age and ability of the individual student. Sophisticated diagnostic and record keeping systems designed to save teacher time were often an integral part of these programs.

In the mid-1970s, this researcher, then a K-12 director of reading, and a teacher trainer, studied the reactions of teachers in the New York area to computers and other technology in the schools. They said:

1. The software either didn't relate to the curriculum or was

designed to be the entire curriculum -- and differed from the teachers' or schools' goals.

2. The equipment was often kept in a separate instructional resource room that took the students away from other important in-class activities.

3. Despite periodic mastery tests, the teachers weren't sure their students were learning. They described a sense of loss of control.

4. The teachers often found it difficult to recognize and understand the components of the instructional programs.

5. Teachers and administrators suspected that the technology was a "fad." Some professed that students needed "real live human beings" and that they were personally uncomfortable with the "machinery."

When asked to comment about CAI in particular, the teachers often voiced frustration. They claimed it fostered learning-in-isolation and focussed on skills that were practiced out of context. Many felt it fostered the teaching-by-objective approach with which, in the mid-1970s, many of them felt uncomfortable. Elementary teachers in particular reported feeling "guilty" and "old fashioned" for not using the technology, but uncomfortable and less effective as teachers if they did. In many cases aides were trained to work in media or audio-visual centers to assist teachers. In one particular school in New York City, an entire class was observed in a CAI math activity. They were fifth graders who visited the computer center for one forty minute period a week. The poor achievers went more often. The room was an ex-classroom that had been wired to contain row after row of some thirty terminals. During the observation, the teacher clung to the back wall of the room while the aide conducted the program. In this class, some students were actively involved in the individualized

interactively branching math activities, some playfully poked the keys and still others seemed to remain cognitively uninvolved. This class was similar to many other lessons observed at that time. At least in this school, for the children observed, something was clearly wrong and did not seem to improve greatly during the next few years.

Since the 1970s, great changes have taken place in the computer industry. Microcomputers are now relatively inexpensive and have the potential for more flexible school use than main frame computers. Karen Sheingold (1981), a researcher at the Bank Street College of Education, conducted a descriptive study supported by the National Institute of Education that examined issues related to the implementation of microcomputer technology in schools. She studied three school systems in the Southwest, Midwest, and Northeast to see how they were using microcomputers. Her report is in some ways similar to the observations and reports described above. She found that the school systems she observed tended to assimilate microcomputer use to their own perceived needs and their own organizational and administrative structures. Although these structures differed, the school systems she studied appeared to be experiencing changes in staffing patterns, roles for teachers and students, and curriculum. The school districts varied in terms of their instructional philosophies, curriculum and instructional organization, and flexibility in terms of innovation and experimentation. However, a number of cross-site trends were found which raise important questions for the use of microcomputers in schools. They are:

1. Differential access to microcomputers. At the elementary level, microcomputers were used more for remediation than for ongoing developmental programs. At the secondary level more males than

females used the computer as did more high math than non-math students. Therefore, levels of achievement and sex seemed to determine students' experiences with the computer.

2. Emergence of new roles in response to microcomputers. Aides were hired and resource rooms often kept computers separate from classrooms. Teachers who spent personal at-home time with computers and student experts who took on instructional roles in school placed new demands on the system.
3. Lack of integration of microcomputers into elementary classrooms and curriculum. Since the computers tended to be kept physically separate from the classroom, there was little integration with the regular class work. In addition, no real teacher-stated goals were evident.
4. Inadequate quality and quantity of software. This was particularly apparent in the non-math areas.
5. Inadequate preparation of teachers for using microcomputers. The teachers felt inadequately prepared to use microcomputers. They judged the in-service courses, university courses, and resource personnel to be inadequate for their needs.
6. Lack of knowledge of effects and outcomes of the instructional use of microcomputers. While in none of the sites reported was the technology intended to change or replace the existing curriculum, the teachers noted social innovations such as interaction, status, and self esteem as observable outcomes.

Sheingold conludes that microcomputers, as they were used in the three school systems she observed, "will not promote particular outcomes. Their

impact will depend, not only on the hardware and software, but on how they are used and on the educational context in which they are imbedded."

Based on the observations and reports cited, it is clear that before computer technology can make a positive impact on instructional programs, the technology must 1) reflect the best professional judgments regarding what is known about students and learning, and 2) reflect knowledgeable views of schools and teaching.

Schools and Technology -- Why?

From this bleak description of technology in the schools, it should come as no surprise that computer and software manufacturers are designing their instructional products primarily for the home rather than the school market, and that school district administrators who are responsible for curriculum development and budget expenditures have been less than enthusiastic in their support of widespread use of computer technology in the schools. This is unfortunate because computers are with us. They are very much a part of the students' world and of the work world in which they will soon take part. Because of this, computers will directly or indirectly be part of the educational scene; educators need to get involved to help shape its course.

There are too many sound educational and social justifications for the use of computers in school to casually dismiss it or sit by and let the change happen. Interactive computers available today can provide strong support to the basic instructional program across the grades and across the curriculum.

Specific educational applications of computer technolgy will be

discussed in more detail in later sections. The most promising of these applications, however, stem from a view of reading instruction that emphasizes problem-solving and strategy development as essential parts of the reading process. Such process-oriented instruction is time consuming, frequently individualized, and requires the teacher to make quick decisions about specific task demands and the student's momentary interaction with the text. Computer technology, which can provide instant process-oriented feedback, would surely be an asset in such educational settings. Used flexibly in the classroom setting, the technology can free the teacher to work with groups or individuals while itself providing the environment for prociess-oriented activity -- with feedback.

Computers are also well adapted to diagnose individual differences in performance, to trace the variations in process that underlie these differences, and to provide activities which permit students to use alternative strategies and make decisions about their effectiveness.

Sheingold (1981) suggests that use of computers tends to be determined by achievement and sex. Her report even cites situations in which teachers refused permission for their students to visit the computer center. The National Center for Education Statistics (1981) reports similar findings. At least one microcomputer or terminal was found to be in use by students in at least 25 percent of the nation's public schools. However, most were used to teach computer concepts; some for remedial, compensatory and enrichment programs. In many secondary schools the differentiation becomes even more pronounced in that the higher achievers (particularly in math) learn to control the technology through courses in computer logic, computer languages, and systems analysis, while their classmates in business

and vocational programs learn clerical and caretaking tasks such as key-punching, data input, and the repair and maintenance of the computer hardware. This becomes a complex problem for educators to contend with. If, in our students' generation, familiarity with computers is to become another mark of the "literate" person, it is important that schools take an early and well thought through stand to direct the kinds of equitable computer opportunities that are provided for all youngsters.

There is also an economic equity issue that must be addressed by the educational community. Although computer games seem to be everywhere in our society, they can be used more by middle class than by poorer children. It is costly at even a quarter a time to play the games that await youngsters at the local hamburger shop, movie theatre, and shopping mall. And it is even more costly to buy a home computer game, despite hook-up to the family TV screen. Because the educational use of computers was unsuccessful in the past, commercial promotion of microcomputers has been directed primarily at home use. Home computers are being advertised on TV, in magazines of all sorts, and even on highway road signs. And people are buying them -- for budgeting, for record keeping, for adult games, and for children's games. Instructional games are available, more will become available; they are being purchased by those who can afford them. If this trend continues (as it no doubt will), public schools may eventually need to provide innovative computer learning experiences for all students before the "new literacy" becomes a perogative of only the more affluent.

One last issue concerns classroom communicative interactions. Studies investigating student-teacher interaction have indicated that poorer readers receive qualitatively and quantitatively different reading instruction

than their higher achieving classmates. The lower achieving students tend to spend less time with their teachers on reading instructional activities and have fewer opportunities to read silently than their peers (Allington, 1980; McDermott, 1978). Similarly, Gumperz, Simons and Cook-Gumperz (1981) report that poor readers' errors tend to be treated out of context and that corrections focus primarily on phonics, and on letter recognition drill. Collins (1981) suggests that the prosodic strategies (oral rhythem and parsing) of poor readers and of speakers of certain dialects tend to provoke similar kinds of word-level corrections by teachers. On the other hand, when better performers and standard-dialect speakers make errors, teachers tend to respond with thought-provoking questions that focus on meaning within the context of the whole work. These studies suggest that a meaning-based instructional focus may unwittingly be determined by who the children are. Although this is a major problem that needs to be dealt with directly by all educators, instructional technology can help ameliorate the problem by providing reading experiences in a more interactively neutral environment.

Directions for Computer-based Reading Instruction

In recent years reading research has found that:

1) reading is interactive -- suggesting use of a broad range of meaning based cueing systems;
2) reading is constructive -- meaning flexes, changes, and grows as the text progresses;
3) successful use of reading strategies requires awareness, decision-making, and appropriate action; and
4) reading strategies change from situation to situation based on the

specific reader, text, and purpose.

Interactive computer technology has the potential to support "kid power" in its largest sense. It can offer learner based and heuristic instruction while encouraging students to develop control over their own skills and strategies. It also has the power to create a wide array of total learning experiences for the development of broadest reader control.

At the present time there are a plethora of computer programs that provide reading practice in bottom-up tasks. Often these stress decoding at the word level, sentence parsing or sentence combining within and between sentences, and surface features at the text level. Few presently available instructional programs provide activities for getting at meaning. In planning such programs, at least three factors that influence the construction of meaning should be considered: 1) the general background and content-related knowledge of the individual reader, 2) the language and structure of the text itself, and 3) the purpose for which the text is being read. Decision making activities that require the student to consider aspects of these factors might be developed using a variety of texts being read for a variety of purposes. Activities could also be developed that require students to decide which information is most helpful in which situations. Activities developing awareness of approaches to learning tasks could help students "learn to learn" (Brown, 1982). Heuristics such as the summarizing rules developed by Brown, Campione, and Day (in press) could help students increase their studying and remembering skills. Activities developing awareness of the demands of a reading task, requiring

judgments about what needs to be known, and encouraging the use of self-regulatory mechanisms to gain that information would be promising contributions to the new instructional technology. Computers also have the exciting potential to place students in shifting roles as readers and authors to thereby extend their understanding of how the author's perceived intent affects organization and interpretation when reading, and how the potential or intended audience affects the language and organization of the work when composing.

Comprehension strategies differ somewhat from one reading experience to another, and when reading becomes difficult or things go wrong, the most appropriate fix-up strategies will also differ. In addition, poor readers tend to forget the purpose for reading, and if they are not reminded, their strategy use may become inappropriate for the task at hand. Computer based activities can be designed to develop awareness of the demands of a reading task, to make judgments about what needs to be known, and to use the self-regulatory mechanisms to gain that information.

The chart below has been adapted from one included in Secondary School Reading: What Research Reveals for Classroom Practice. It lists some of the reader based knowledge and strategies that might be considered when planning process-oriented instructional activities. (Further detail can be found in Langer, in press.)

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Although the division into before, during, and after has been made for purposes of clarity, most of the strategies are used throughout the

Table 1.

Before	During	After
content related background knowledge	predicting what comes next	organization of recall
text-related knowledge (format, text structure)	integrating (constructive aspects)	organization of story (recall of structure as well as recall of details)
specific vocabulary knowledge	using self-questions	devising post-questions (textually-and scriptually-based)
understanding the purpose for reading	knowing when additional information is needed and how to get it	long and short term recall of understanding of task
awareness of form, style, genre	keeping purpose for reading in mind	knowing when being uncertain is okay
knowing what one knows and needs to know	using flexible strategies at word, sentence and text level	judging if information gained is sufficient based on purpose
	monitoring inconsistencies	reacting to author's point
	becoming aware of author's goals	

reading process and can therefore be adapted to instructional purposes in a wide variety of combinations not shown. This focus is not essentially different from that which can be offered by a process oriented teacher who has the time, the knowledge, and the flexibility to help students become more efficient and confident strategy users. However, instructional technology can be helpful in the very pragmatic sense that more students can be engaged in absorbing learning activities more of the time and teachers can have more flexibility in allocating their own time. It is likely that for the greatest effectiveness, computer-based activities need to be introduced in the classroom and controlled by the classroom teacher as part of an overall functional support to the student's total instructional program.

Some computer based activities that could make a difference:

1. Increase student's awareness of text features a) to meet text-based needs, and b) to override text-based problems.
2. Model a metacognitive strategy in the presentation of a particular reading activity. Gradually turn the decision-making, and later the question-generation, over to the student.
3. Provide concept and language awareness activities prior to reading to help students think about what they already know about a specific topic. Have them anticipate what they will read in the text.
4. Provide activities which require decisions about ideas in the text that may or may not make sense or are not necessarily consistent with one another.
5. Help students decide how thoroughly they must learn the textbook material based on the purpose for reading.

6. Develop activities which ask adjunct questions to teach self-questioning before, during, and after reading.
7. Vary audience, author, or voice to help students become aware of these shifts.
8. Vary text clues at word, sentence, and text level and have students develop sensitivity to their varying levels of usefulness.
9. Have students judge what they think will be easy/difficult for their classmates to understand. Why? What would make it different?
10. Present writing-in-progress and have student determine if author is exercising strategies that he or she knows.

Malone (1980) in his dissertation dealing with motivational aspects of computers suggests that computers have unprecedented potential to provide captivating learning activities by creating situations that engage students' notions of challenge, fantasy, and curiosity. In addition, they have the potential to expand the set of meaningful contexts for learning. Broad guidelines for computer based activities of the future might be to:

1. Provide experiences and environments that cannot, under usual circumstances, be provided by the regular teacher in the regular classroom; do not replicate workbooks, skill sheets, and texts.
2. Create activities that require the student to make decisions, evaluate and judge their effectiveness, and gain self sufficiency; do not create activities that merely tell students whether they are right or wrong.

3. Remember that in most reading situations there is rarely a right or wrong but a more or less appropriate interpretation; create activities that reflect this reality.
4. Remember that the computer is a potentially exciting motivational tool for learning; be ingenious with its potential to thoroughly involve students in the learning situation.

Computer Technology and the General Curriculum

As suggested above, to be of maximum instructional benefit, technologies and games must be based on a sound cognitive theory and structured to develop reader independence in functional situations. In addition, it is important that the activities augment the developmental programs currently in use, and be sufficiently broad to permit practice of decision making in specific types of cognitive interactions (reader with a particular type of text for a specific purpose) across a wide range of age, ability, and interest levels. This requires that software programs be developed for use at a range of interest and achievement levels, for separate grade levels. The programs would need to be generically organized to reflect cognitive processes, function, and task rather than along more traditional skills hierarchies.

Because reading experiences are never content-free, aspects of the programs might be based on process-oriented tasks in a variety of subject areas, with content and topic appropriate for particular age and grade levels. In this way the highly functional and cognitively sound notion of reading across the curriculum would become an integral component of the program. In addition, the cognitively related communication domains of reading and writing could be integrated via activities that capture and extend their use in naturally occurring contexts. It is important that

the program developer always consider the motivational factor and strive to provide lively activities which directly engage the students in tasks that involve thinking and reasoning. The overriding goal, of course, is to provide learning experiences that are so well grounded in cognitive theory, and that so ingeniously utilize the technology, that students become deeply engaged in a system of activities designed to help them gain control of their own learning.

Advantages for Teachers, Students, and Administrators

Teacher benefits. The realities of the usual classroom instructional program preclude personalized process-oriented instruction from becoming a pervasive reality without some sort of assistance to the teacher. Often teachers are aware of the kind of instructional interactions that would benefit a youngster, but do not have the time for the needed conference activities. At times teachers are aware that a strategy-based activity is in order, but do not know how to become appropriately non-directive while still providing the necessary guidance. In either case, computer-based programs would be well-received by teachers because the specific activities could be chosen based on the teacher's perception of what is instructionally appropriate for the particular child. Computer technology would also permit teachers to better organize the time they spend with individuals or groups, to make decisions about how to best develop the reading skills of their students, and to integrate this into the subject area curriculum.

A teacher-as-programmer option might also be provided. Although a few teachers would avail themselves of this option at the present time, computer technology is becoming so large a part of our society that simple

programming skills will soon be sought by many school systems and by many teachers. Because teacher-as-programmer would permit the teacher to maintain ultimate control over instructional activities, this would be a pedagogically sound component of any program. Teachers then would benefit from computer-based programs in two ways: 1) they would maintain autonomy in selection of learning goals while providing activities with interactive feedback to their students, and 2) they would be able to reallocate instructional time among whole class, large group, and small group activities relying on the technology for specific blocks of instructional time.

Student benefits. Students frequently find computer activities fun, engaging, and highly motivating. They often become particularly attentive when receiving immediate response and guidance from the computer. Also, there is an element of "kid-power" in the acquisition of strategy control and increased understanding which seems to have short term as well as long term benefits. Because of the increased motivation and involvement, student time-on-task, also a positive outcome, increases.

Administrative benefits. Instructional programs must, of course, be developed with a thorough understanding of administrative as well as classroom needs. Administrators presently have three concerns which cannot be answered adequately by traditional programs and methodologies, but that may successfully be answered by computer technology. Because administrators are well aware of the varying instructional approaches and offerings from class to class, they often seek to adopt curriculum materials which provide instructional continuity over and above what might be offered in any individual classroom. Therefore, a process-oriented system which augments, but does not supplant, the basic instructional program may help minimize differences

in approaches to teaching while providing useful personalized instruction. With the national stress on literacy skills, activities which focus on reading and writing development across the curriculum would be considered an instructional asset by many administrators concerned that insufficient classroom time is being spent on reading and writing instruction. Because process-oriented computer programs can benefit the entire age and achievement range of students, this third aspect of innovative technology becomes a desirable instructional component from an administrative standpoint.

Organization and Use Within a School

Because library media centers have gained in prominence as centrally-located resource centers for individual and small group learning, it is likely that many schools will place terminals and software packages in this area of the school. Although it may at first seem cost efficient to place all computer-based software and equipment in this center, as the technology gains acceptance, more widespread use will make availability in individual classrooms more desirable.

Classroom computer centers will permit students to carry out classroom "projects" (such as mail messages and billboard news) with greater ease and will also permit a more flexible classroom organization. Some schools have developed additional subject-based resource centers which provide subject area work in an individualized environment. Often these centers have low teacher-pupil ratios and focus on remedial or supplemental instruction. Although strategy-based programs would be useful in such a setting, it is important to stress the advantages of the technology for all youngsters.

Computer-based reading instruction would be best envisioned as an adjunct to all aspects of the instructional program, found in library media

centers, classroom computer centers, and resource centers as well. This would require careful consideration of the developmental aspects of reading, from initial language play and print awareness activities through higher-level processing and metacognitive tasks. Program components would need to be cross referenced for easy use by teachers with differing needs. This would require indexing of content area, type of text, task demands, level of difficulty, and the age range for which a particular activity is most suitable.

Such potentially broad-based use of computer technology would permit positive focus on reading development across the curriculum for children at all grade levels and stages of achievement. For this to occur, computer-based instructional programs must be designed with a thorough understanding of the variety of possible uses within the school complex.

Gaining Acceptance of Computer Technology

Computer technology has progressed to the point where it can make significant contributions to instructional effectiveness and student learning at comparatively low cost. As we have seen, computers are well adapted to focus on individual strategies to trace variations in process, and to provide personalized, strategy-based instruction. However, the problem of gaining acceptance for computer technology remains a major issue.

If computer technology is to be widely used in schools, at least four conditions must be met:

1) easy terminal and software accessibility for teachers and students;
2) adaptability of program activities to the teacher's instructional goals;
3) easy identification of program components and instructional goals; and

4) teacher and administrator comfort with computers.

Although each is important, the last point may prove to be the major stumbling block. If teachers and administrators fail to become comfortable with computers, original purchases may never be made, or the technology may be used well in a few schools spotted across the country, used poorly in others, and allowed to gather dust next to the microfiche readers in still others -- and the students will lose.

Computer Literacy

The resistance to computer technology in schools is widespread. Discussions with school superintendents, administrators, and teachers indicate a generalized unease with computers, yet a curious desire to know more. Because the use of computers is becoming so widespread in so many aspects of our society, some educators are beginning to realize that schools will be at a serious disadvantage if the technology continues to be ignored. For the educators of today to gain comfort with the technology and its potential, a large effort may need to be launched to help them become more "computer literate." There are a number of specific activities that can be planned; administrators, teachers, principals, school board members, and members of the community can participate in an informal, hands-on "computer literacy" program. To organize this project, a few microcomputers with such simple games as "hangman" can be placed in central areas where people can "practice" and play the games. The teachers' lunchroom, a hallway outside the local school board meeting, a teacher center--all are likely places. As the games get a bit more complex, programs in reading and writing could replace the simpler games. As adults become more comfortable with the technology and engage in the learning activities, they are more likely to understand the

innovative aspects of the technology and its relevance to their own goals.

Another way to involve administration and faculty members in "computer literacy" is through the growing acceptance of computers by business and mathematics teachers. More and more secondary school mathematics and business education departments have begun to offer "Introduction to Computers" courses as well as courses in the use of various computer programming languages. Some microcomputers are being used for these courses, and computer-based instructional programs are purchased or prepared by the teachers themselves. The "Computer Literacy" effort can emanate from the teachers and students in these departments. There might be days when they present "Computer Fairs"--in each school auditorium and even in the local shopping center. All classes within a school district would be scheduled to attend. Games and coursework could be available for the novices to "play" and some reading programs might also be included in the offerings.

Decisions about large expenditures such as computer technology are best made when both teachers and administrators are involved in the planning and development. Often, a pilot program is begun with enthusiastic teachers, principals, and curriculum coordinators who end up "selling" the program to others. In this same way it is possible for a school librarian and a few classroom teachers to begin together to use the computer based technology both in classrooms and in library media centers as part of the ongoing instructional program. Since activities and terminals as well as printers would be available in the media center, it is likely that other students and other teachers would become curious and possibly even involved. It cannot be suggested too strongly, however, that administrators and teachers

should be exposed to the "literacy" program over an extended period of time until they are comfortable with the technology. Neither in-service courses nor one or two week summer courses seem to work. An ongoing support network supplied "on-call" seems to make a greater difference in learning, attitudes, and acceptance.

Computer companies such as Apple and Atari have become actively involved in the support of innovative microcomputer use, generally through grants for equipment. Boards of advisors review grants and encourage the development of new applications of the technology. At the present time, Apple is more interested in software development while Atari's interests focus on models of use. Atari has funded a travelling computer van that visits schools and introduces students and their teachers to computers. In addition, large public-access educational computer centers for children have been supported by Atari at the Lawrence Hall of Science in Berkeley, California, and the Capitol Children's Museum in Washington D.C. Similar cooperation with computer companies might be sought to effect changes in attitudes about computer-based instruction on the part of all members of the school community, including school board members, central administration, teachers, and parents. Computer users in education groups are being formed in local areas across the country. They are made up of educators and members of the computer industry and have rich potential to plan and implement "literacy" projects in local communities and provide a forum for articulation of ideas about the future use of computers to teach literacy skills.

Summary

There is no doubt that the computer revolution is with us, that it is affecting schools, and that this trend will continue with or without the involvement of the educational community. Today's students need to be prepared for participation in a technological society that is likely to require some degree of computer literacy even for basic entry level jobs. Instructional use of computer technology is presently limited in scope, haphazardly organized and administered, and accompanied by software that does not reflect current knowledge of the reading process. The majority of teachers and administrators are uncomfortable with computer technology and are uncertain about its ability to benefit school programs.

Based on what is known about computers, reading strategies, and cognitive theory, there is no doubt that computer technology has the potential to make a difference in schools. However, program development and school site implementation need careful guidance from educators and researchers who are knowledgeable about process research, aware of school needs, and sensitive to school conditions. If the issues of implementation and acceptance are not jointly addressed by educators and the computer industry, innovative learning experiences and computer literacy may only be accessible to select groups -- increasing rather than helping to eliminate equity problems in both school and society.

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